Main Research Results

1. A chemical soil-washing method for remediating paddy fields contaminated with cadmium

Japanese paddy fields have often suffered from soil contamination by cadmium (Cd) derived from old mines and refining plants. Excessive intake of Cd is harmful to a person's health, as has been shown in the case of itai-itai disease. To ensure the safety of foods, the concentration of Cd in staple crops, and especially in rice, should be below a standard value, because half of the Cd intake by Japanese people is derived from rice.

Current Japanese regulatory laws have designated those paddy fields that produce rice grains containing more than 1 ppm of Cd as "contaminated paddy fields". There have been efforts to remediate these paddy fields by soil dressing, but this process is becoming increasingly difficult as a result of its high cost and the difficulty in obtaining uncontaminated soil. As a result, we have developed a chemical soil-washing method for the restoration of Cd-contaminated paddy fields.

First, we tested the efficiency of a variety of chemicals in extracting Cd from a paddy soil sampled from Nagano Prefecture. We selected ferric chloride ($FeCl_3$) as a promising wash chemical because it is inexpensive and highly effective in extracting Cd, and because it imposes a low environmental burden. The mechanism of extraction of Cd was attributed to a significant pH reduction in the soil when $FeCl_3$ was applied. The reduction was caused by the release of protons during the generation of iron hydroxide with a small solubility product (Ksp = 3.16×10^{-38}) from $FeCl_3$, as indicated in the formula below. The usual amount of $FeCl_3$ applied ranged from 1 to 7 t ha^{-1}.

($FeCl_3 \rightarrow Fe^{3+} + 3Cl^-$, $Fe^{3+} + 3H_2O \rightarrow Fe(OH)_3 + 3H^+$)

Next, for the on-site washing experiment, a plot (109 m^2) was set up in a farmer's paddy field in Nagano Prefecture. It was surrounded by thick plastic sheets to prevent the water from leaking out. After the plot had been submerged, we applied $FeCl_3$ to the water, mixed the soil with the water to extract Cd from the soil, and then drained the contaminated wastewater. A standard puddling machine was sufficient for the mixing process. The paddy field was then rinsed several times with agricultural water to eliminate any remaining Cd and chlorine. After the wastewater had been introduced into a stationary-type wastewater-treatment machine and a chelating agent in the machine had selectively removed the Cd from the wastewater, the purified water was drained (Fig. 1).

The amount of soil-Cd in the washed plot was reduced to approximately 55% of that in the unwashed plot, as determined by extraction with hydrochloric acid at 0.1 mol L^{-1}. The effect of the washing treatment lasted until at least the end of the growing period.

Moreover, application of the washing method had no negative effects on the growth and yield of paddy rice (variety: Akitakomachi), and the Cd content in rice straw and brown rice was markedly decreased (Fig. 2). The washing method developed in this study shows promise for remediating Cd-contaminated paddy fields. (T. Makino, Y. Maejima, Y. Sakurai, and T. Otani)

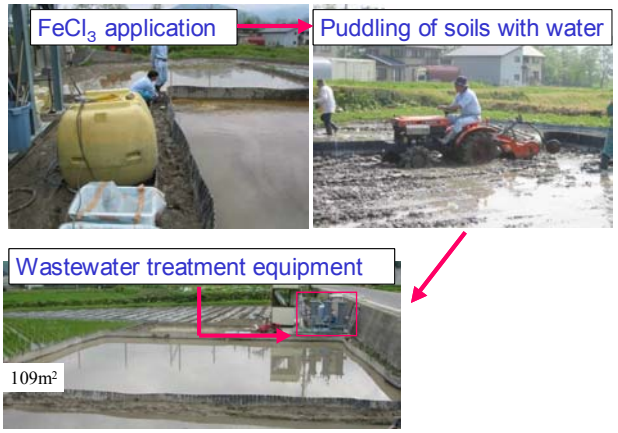


Fig. 1 On-site soil washing in a Nagano paddy field

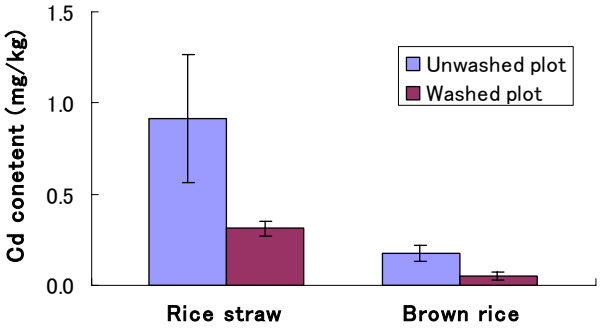


Fig. 2 Changes in the Cd content of rice straw and brown rice with soil washing treatment

2. System for simulating nitrogen turnover in upland soils in Japan

Nitrogen (N) is one of the essential elements for plant growth, but its inappropriate application to agricultural soils can cause environmental pollution, such as nitrate contamination of groundwater. Therefore, various agricultural practices have been developed and applied to reduce N leaching from agricultural fields by improving the recovery rate of N by the crop. However, such practices are not always as effective as expected because of fluctuations in N dynamics in the soil (e.g. by minerali-

zation, immobilization, and denitrification) and in field conditions (e.g. weather, soil characteristics, and method of field management). The purpose of this study was to develop a simulation system that could be used easily to manage the quantitative evaluation of N dynamics in the soil under field conditions.

The simulation system is based on the N turnover model developed at Rothamsted Experimental station in the UK (Bradbury et al., 1993). The model assumes that part of the inorganic N mineralized through the decomposition of applied organic materials, crop residues, and soil organic matter is immobilized in either the soil microbe fraction or the soil humus which has a longer half-life than the former fraction. It also assumes that the decomposition of organic materials that have a carbon to N ratio (C/N ratio) above a certain level requires sufficient amounts of inorganic N in the soil solution and continues only while sufficient amounts exists.

The system that we developed enables the user to input data such as the weather conditions and the type, dosage, depth, and application dates of fertilizers and/or manure (Fig. 1). The decomposition rate of organic N was modified for volcanic ash soils by reference to the phosphate absorption coefficient (PAC). This is because these soils, which are characterized by particularly high PACs, are predominant in upland fields in Japan, and because the decomposition rates of N in the soil organic matter (SOMN) in these soils are known to be slower than in other soils because of the high PAC.

The system displays weekly amounts of variables, such as N uptake by the crop, N loss through denitrification and bypass flow, N leaching below 1.5 m depth, SOMN associated with the turnover of N, the undecomposed N fraction in applied organic materials, ammonium N retained in the soil profile (0- to 1.5-m depth), nitrate N remaining in the soil layers, and carbon dioxide emission from the soil profile (Fig. 2).

Implementation of the system will help users to evaluate the effectiveness of the standard application rate of fertilizer on crop production as well as of newly developed technologies on the growth of the target crop under conditions of ongoing management at the site. It will also help in the quantitative evaluation of whether the applications of these standards and technologies are

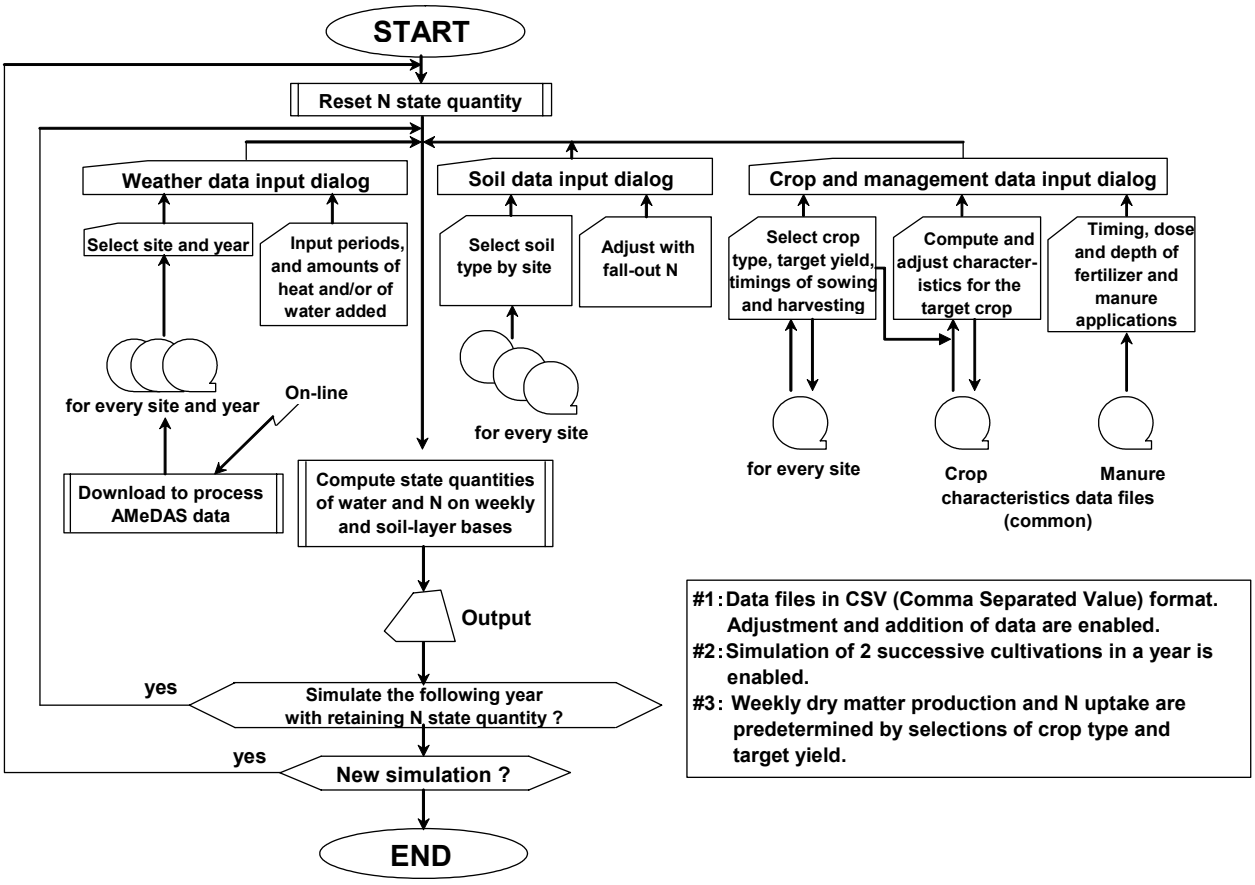


Fig. 1 Flowchart of system used to simulate N turnover in upland soils.

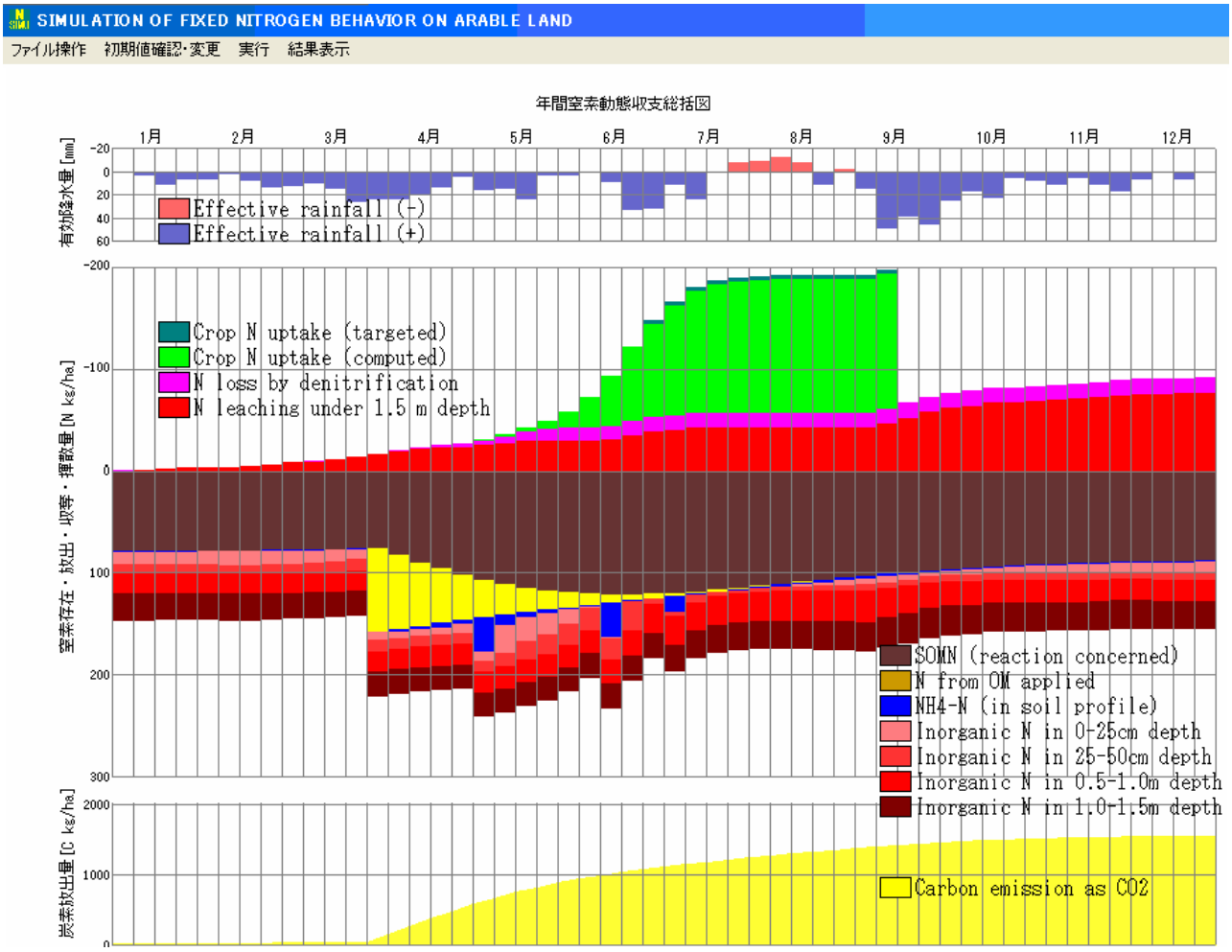


Fig. 2 Example of an output of the simulation system.
Simulation conditions: 1) weather data—from Okazaki in Aichi Prefecture (average over 33 years); 2) soil type—fine textured yellow soil, Tadenuma series; 3) crop cultivation—wheat, sown on 3 May and harvested on 14 September; 4) target yield—4.4 t ha^{-1}; 5) manure application—dose of 20 t ha^{-1} applied into 0- to 25-cm depth on 25 March; 6) fertilizer application—total dose of 60 kg ha^{-1} applied into 0- to 25-cm depth on 3 May, 15 June, and 3 July.
Note: N uptake, denitrification, leaching, and CO_2 emission are shown as cumulative amounts, and the other variables are shown as abundances in the soil profile.

likely to be environmentally safe. (S. Itahashi, K. Hayashi, M. Takeuchi)

Reference

Bradbury, N. J., A. P. Whitmore, P. B. S. Hart and D. S. Jenkinson (1993) Modelling the fate of nitrogen in crop and soil in the years following application of ^{15}N-labelled fertilizer to winter wheat. Journal of Agricultural Science, Cambridge, 121: 363–379

3. The Asian-Pacific Alien Species Database (APASD) system: development and placement on the Internet

In 2003 an International Seminar was held in Tsukuba to disseminate knowledge on biological invasions upon the countries in the Asia Pacific region by alien species and to develop a database for accumulating and sharing data on these species. Our Institute took on the task of developing the database system, and it was completed and made available on the Internet in November 2004. At a workshop held in Taiwan in 2004, several researchers and specialists lectured on the alien species that had invaded into their countries, and these data were input into the database. This database system was named the Asian-Pacific Alien Species Database (APASD), and it is a relational database with web application. Users of

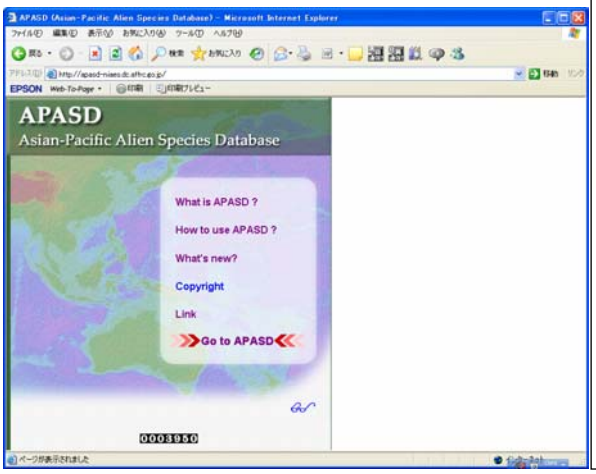


Fig. 1 Accessing the Asian-Pacific Alien Species Database.

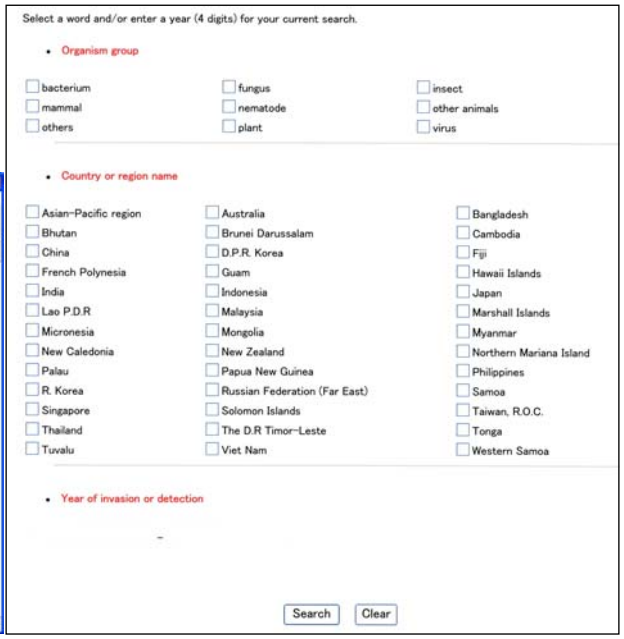


Fig 2 Searching for a target species. The user starts by selecting the organism group, and/or country name, and /or inputting the year of invasion.

the system can easily input, search, and read large amounts of data (Figs. 1 and 2).

The APASD has three functions. The first is for common users, who may freely read APASD data on the Internet. The second is for contributors, who may input various items of data on species, including photos and references, into the APASD through the Internet. The third is for administrators, who may manipulate items in the master tables such as organism name, country or region name, categories of invasion and establishment, and habitat. They transfer the data written by contributors from the temporary system to the regular system after they have been checked.

The target species to be accumulated in this database comprise those alien organisms, such as plants, mammals, insects, nematodes, the other animals and microbes (bacteria, fungi, viruses), that inhabit the agro-ecosystems of the Asia-Pacific region. Our intention is to accumulate data mainly from Japan and other Asian countries.

Data such as taxonomic name, situation of establishment, expansion of distribution area, ecological and economic damages, characteristics of reproduction and growth, countermeasures, references, and photographs can be accumulated and read. Contributors in a number of countries can input data on the same species at the same time, and users can compare those data on the same page. By using the APASD, we can not only share and exchange data from many countries, but also develop an international network of alien species by using the system as a tool for the many people in these countries who are interested in alien species.

The APASD can be accessed in English through a link to “DATABASE AND DATA MAP” on the NIAES homepage, or directly at the following URL (http://apasd-niaes.dc.affrc.go.jp/). (M. Matsui)

References

Matsui, M. et al. (2004) Development of the Asian-Pacific Alien Species Database (APASD). Proceedings of an International Workshop on the Development of a Database for Biological Invasion in the Asian and Pacific Region, Taichung, Taiwan, 2004, sponsored by FFTC, ARI, BAPHIQ of Taiwan, and NIAES, pp. 44–55.

Yamanaka, T. and M. Matsui (2003) Development and utilization of APASD (Asian-Pacific Alien Species Database). Proceedings of an International Seminar on Biological Invasions. Environmental Impacts and the Development of a Database for Asian-Pacific Region, Tsukuba, Japan, 2003, sponsored by NIAES and FFTC, pp. 155–176.

4. Effect of change in land use from paddy rice to upland crop cultivation on methane and nitrous oxide emissions

Since the rice production adjustment policy was implemented in 1975, temporary cultivation of upland crops for a few or several years in drained paddy fields has been recommended to farmers in Japan. The area of drained paddy fields used for upland crop cultivation is now 740 000 ha—about 30% of the total upland crop cultivation area in Japan. Despite the fact that the dynamics of greenhouse gas emissions may be changed significantly by this drainage of paddy soils for upland crop cultivation, owing to changes in soil physicochemical and biological properties, studies on greenhouse gas emissions from drained paddy soils are limited. We therefore measured methane (CH_4) and nitrous oxide (N_2O) emissions from both paddy fields under irrigated rice cultivation and drained fields under upland crop cultivation.

Three kinds of cropping system, single cropping of paddy rice (PR), single cropping of upland rice (UR), and double cropping of soybean and wheat (SW), were used for 2 years (2002–03) in the experimental fields of NIAES. CH_4 and N_2O fluxes from the PR, UR, and SW plots were measured continuously and simultaneously with automated flux monitoring systems. CH_4 emission from the PR plots in 2003 was 5.8 times higher than that in 2002, mainly because of a prolonged period of continuous submergence in 2003. In contrast, slight absorption of CH_4 was observed in the UR and SW plots throughout the year (Fig. 1). In the UR and SW plots, significantly higher N_2O emissions were observed in the summer season (from July to August). In the SW plots, a significant increase in N_2O emission was also observed in the spring of 2003, during the flowering to ripening stages of the winter crop (wheat). Other temporal increases in N_2O fluxes were occasionally found in the UR and SW plots after heavy rainfall or crop harvesting. In contrast, N_2O emissions from the PR plots were low during the paddy rice cultivation periods (Fig. 2).

In summary, the effect of land-use change from paddy rice to upland crop cultivation on greenhouse gas emissions was characterized mainly by the absence of CH_4 emission and an increase in N_2O emission. Compared with the results of other studies in Japan, the cumulative CH_4 emission in our PR plots was significantly lower than the average value (19.0 ± 12.5 g CH_4 m^{-2}), whereas our cumulative N_2O emissions in the UR and SW plots were comparatively high. The combined net global warming potentials (net GWP) as a result of the CH_4 and N_2O emissions were 100 to 442, 102 to 110, and 79 to 146 g CO_2 m^{-2} in the PR, UR, and SW plots, respectively. Net GWP in the PR plots in 2003 was extremely high compared with the other values, owing to the high levels of CH_4 emission, thus illustrating the par-

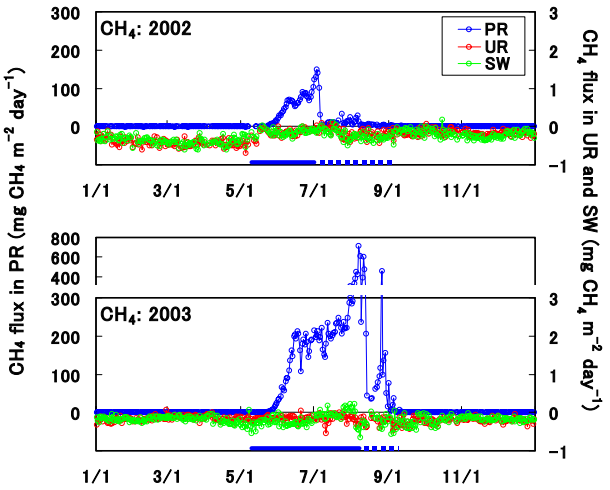


Fig. 1 Seasonal courses of CH_4 fluxes in fields under single cropping of paddy rice (PR), single cropping of upland rice (UR), and double cropping of soybean and wheat (SW). Horizontal bars at bottoms of the figures show periods of submergence of PR plots.

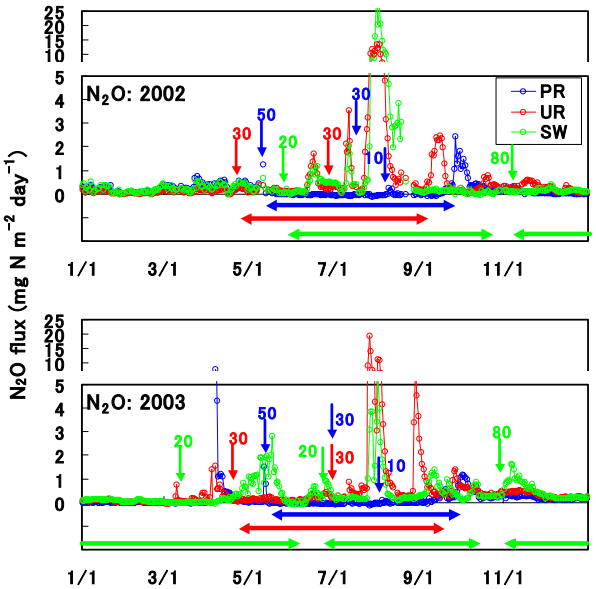


Fig. 2 Seasonal courses of N_2O fluxes in fields under single cropping of paddy rice (PR), single cropping of upland rice (UR), and double cropping of soybean and wheat (SW). Vertical and horizontal arrows in different colors show rates of N fertilizer application (kg N ha^{-1}) and periods of the crop cultivation, respectively, for the corresponding cropping systems.

ticular importance of water management during the paddy rice cultivation period in relation to CH_4 emission. This also suggests that drainage of paddy soils for upland crop cultivation is effective for reducing net GWP in paddy fields with high potential for CH_4 emission, such as those that are poorly drained or have low soil iron content. Our results can also be utilized in Japan's National Greenhouse Gases Inventory. To further improve the inventory, greenhouse gas emissions from drained paddy fields in various locations and with various kinds of crop cultivation will need to be measured. In particular, N_2O emissions from fields with high levels of N fertilizer application, such as those used for vegetable cultivation, must be carefully taken into account. (S. Nishimura)

5. Invasion and occurrence of the banana moth, *Opogona sacchari* (Bojer) (Insecta, Lepidoptera), over a wide area of Japan

A total of nearly 450 species of insects and their kin, including plant-parasitic mites, spiders, and nematodes, were introduced into Japan between 1868 (the Meiji Era) and 2002 (Ecological Society of Japan, 2002)—an average of 3 species a year. Recently, the number of invasive insects has increased because of the rapidly increasing importation of agricultural products and other material, even though Japanese plant quarantine has been reinforced. Artificial conditions such as those found in greenhouses or fostered by global warming may set the stage for the successful establishment of invasive insects in Japan.

The banana moth, *Opogona sacchari* (Bojer) (Photo 1), is a large species of the family Tineidae. The moth's wingspan is almost 20 mm in males and 23 mm in females, and the mature larva (Photo 2) is 30 mm long. This species is known as a pest of many tropical crops, fruits, and ornamental plants in places such as Africa, Europe, the West Indies, Brazil, and the southern United States. It has rarely been recorded in Asia. It was first detected in Japan in 1986 at the Moji Plant Protection Station, where larvae were found feeding on the stem of *Dracaena* sp. (Agavaceae) imported from Madagascar. The other recorded occurrence in Japan was in Chichijima, Ogasawara, in 1999.

However, through identifications that we performed in cooperation with Osaka Prefecture University, we have other records of this moth from many localities in Japan (Table 1). Most of the records are based on identification requests from Agricultural Experimental Stations in Japanese prefectures.

Table 1 shows that this pest species has a wide host range in Japan, as is the case in other countries. It also

Photo 1 Adult *Opogona sacchari* (Bojer).

Photo 2 Mature larva of *Opogona sacchari* (Bojer) (blue arrow) and the damage caused to the graft union of a *Ficus benjamina* (Moraceae) by this insect pest.

damages other plants such as potato, eggplant, and corn, although damage to these plants has not yet been recorded in Japan. It is known as an important pest of stored products.

In Japan, *O. sacchari* appears to occur in the warm regions of Honshu, Shikoku, Kyushu, and the Ryukyu Islands. However, even in cool regions such as Hokkaido and Tohoku, we have pointed out to farmers its presence in greenhouses. (S. Yoshimatsu and K. Yasuda)

Reference

Yoshimatsu, S., Y. Miyamoto, T. Hirowatari and K. Yasuda (2004) Occurrence of *Opogona sacchari* (Bojer) in Japan (Lepidoptera, Tineidae). Japanese Journal of Applied Entomology and Zoology, 48: 135–139. (in Japanese with English summary)

Table 1 Records of *Opogona sacchari* (Bojer) in Japan

Date	Locality	Host plant (Family name): substrate or damaged portion
July 1986[a]	Kanmon Port, Fukuoka Pref.	*Dracaena* sp. (Agavaceae): stem
1988	Kimitsu City, Chiba Pref.	*Pachira glabra* (Bombacaceae): apical portion of current shoot
July 1992	Onna-son, Okinawa Pref.	*Ficus benjamina* (Moraceae): graft union
October 1993	Kaidu-cho, Gifu Pref.	Bromelia (Bromeliaceae): leaf bud, stem near ground, and core
January 1993	Itako-machi, Ibaraki Pref.	*Yucca* sp. (Agavaceae): xylem
September 1994–February 1995	Imaichi-cho, Nara City, Nara Pref.	Potted *Cymbidium* sp. (Orchidaceae): compost
March 1995	Imai-cho, Nara City, Nara Pref.	Potted *Cymbidium* sp. (Orchidaceae): compost
April 1997	Mashiki-machi, Kumamoto Pref.	*Dracaena concinna* (Agavaceae): branch and underground parts *Philodendron bipinnatifidum* (Araceae): tuberous roots *Tulipa* sp. and *Lilium* sp.(Liliaceae): bulb
April 1997	Tamagusuku-son, Okinawa Pref.	*Dracaena* sp. (Agavaceae): branch
August 1998	Tamatsukuri-machi, Ibaraki Pref.	*Pachira glabra* (Bombacaceae): epidermal cell and pith
October 1998	Kamisu-machi, Ibaraki Pref.	*Pachira glabra* (Bombacaceae): nursery stock
April 1999	Tosa City, Kochi Pref.	*Dendrobium* sp. (Orchidaceae): roots, bulb and around compost
September–October 1999[b]	Chichi-jima, Ogasawara, Tokyo	Concentrated chicken feed
2000–	Kitakanbara-gun, Niigata Pref.	*Begonia* sp. (Begoniaceae): bulb *Aloe arborescens* (Liliaceae), *Musa* sp. (Musaceae), *Passiflora edulis* (Passifloraceae)
September 2001	Hachijo-jima, Tokyo	*Dracaena* sp. (Agavaceae), *Strelitzia augusta* (Musaceae) and *Chamaedorea seifrizii* (Palmae)

[a] Detected at the Moji Plant Protection Station and reported by Baba (1990).

[b] Reported by Takahashi et al. (2000).

Major Symposia and Seminars

1. Second Meeting for the Presentation of NIAES Research Topics

The Second Meeting for the Presentation of Research Topics, "Aim for a safe and reliable agricultural environment," was held on 12 April 2004 at the Tsukuba International Congress Center. NIAES became an Independent Administrative Institution (a semi-autonomous agency) on 1 April 2001. One year later, on 23 April 2002, the first official meeting to present our research topics to the general public was convened to commemorate the first anniversary of the reorganization of the Institute. The purpose of this year's meeting—the second—was to introduce the results of research performed up until midway through the current Mid-term Plan. There were 175 attendees: 84 from outside NIAES and 91 from the Institute.

The opening address was given by Katsuyuki Minami, Director General of NIAES, and was followed by a special lecture, "Agricultural scenery: its significance, preservation, and practical use " by Isoya Shinji, President of the Tokyo University of Agriculture. After that, the following 5 recent NIAES research topics were presented: "Evaluation of habitats of living organisms in the agricultural environment" (D. Sprague, Chief of Ecological Management Unit), "Risk of invasion by exotic insects and evaluation of the influence of such invasions on the ecosystem " (M. Matsui, Head of Entomology Group)," "Evaluation of methods of utilizing microbiological inventories " (S. Tsushima, Chief of Microbial Systematics Laboratory), "Analysis of the influence of agricultural activity on water quality " (M. Saito, Director of Department of Environmental Chemistry), and "Development of technology that remediates soils polluted with cadmium " (S. Ono, Head of Heavy Metal Group).

The last program, chaired by Mitsunori Oka, Director of Department of Biological Safety, covered questions and answers on such issues as the importance of using a multidirectional approach to solve agro-environmental problems and the duty of researchers to present their results proactively and thus improve the environmental consciousness of producers and consumers. This argument was summarized as follows: We need to develop a system whereby government officials, researchers, producers, and consumers can have a lively exchange of opinions. Fresh routes for solving Japan's agro-environmental problems could flow from the arguments that might develop during the exchange of such opinions.

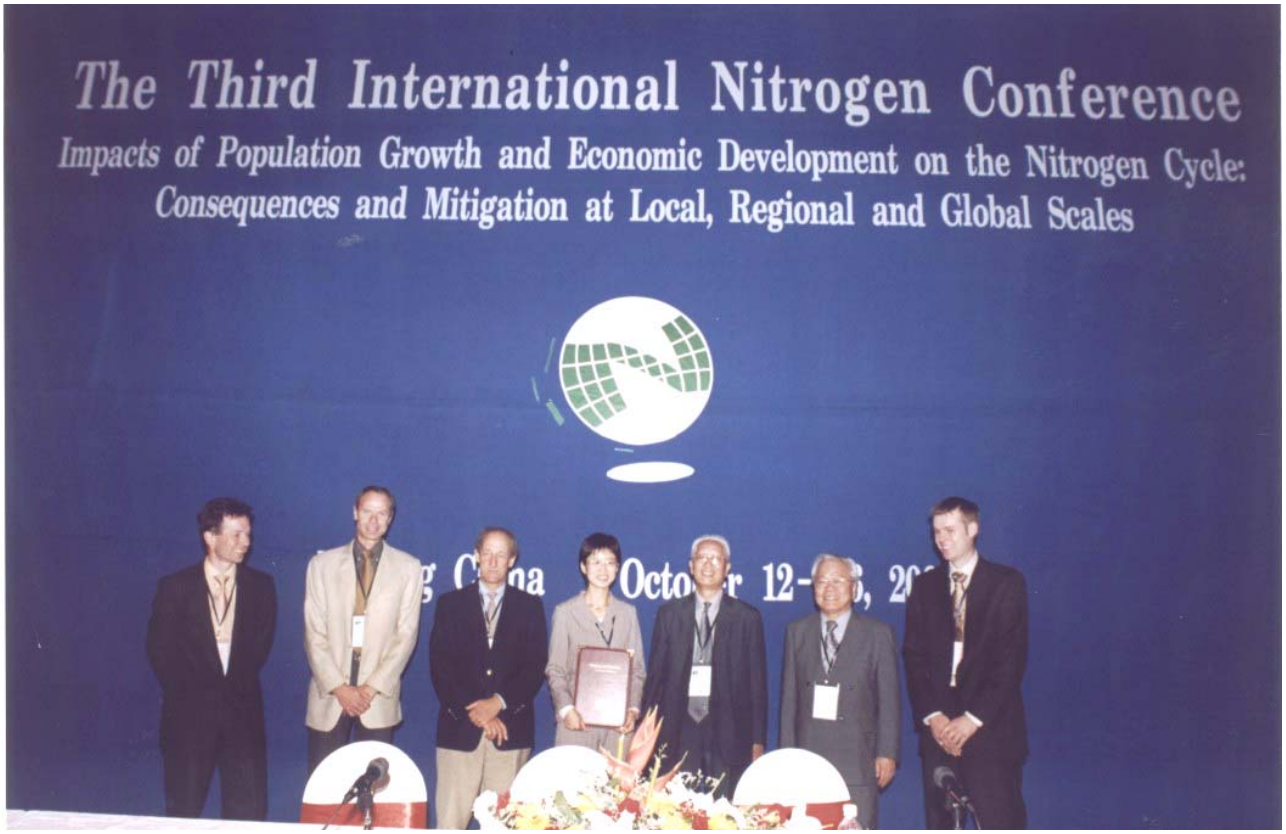
Presentation by Prof. I. Shinji, Tokyo University of Agriculture.

The questionnaire on this meeting gathered the impressions and opinions of 48 participants . The feedback was generally favorable: for example, "Very useful," or "The special lecture in particular was interesting." Other opinions, such as, "Please facilitate the use of useful data, such as the microbiology database," "There is a need to increase opportunities for interaction with the general public," and "NIAES should present proactive proposals to society," suggest that the general public has major expectations of NIAES.

The next meeting will be held when the present Mid-term Plan has finished and NIAES is aiming at a new target. In taking the opinions that we obtained here into account, we must ensure that the next meeting serves as an opportunity to present our results to a large number of people. (I. Taniyama)

2. Third International Nitrogen Conference and Sino-Japan Workshop on Impacts of Nutrient Cycling in Rice-based Ecosystems and their Environmental Consequences

Nitrogen is an essential element for food production. However, N loading of the environment causes deterioration of water quality, atmospheric pollution such as acid rain, and increases in greenhouse gas emissions. The International Nitrogen Conference was initiated in The Netherlands in 1998 with the aim of achieving proper control of N loads at local, regional, and global scales. After the second conference, in the United States in 2001, the third conference, sponsored by the Chinese Academy of Sciences (CAS), was held in Nanjing, China, from 12 to 16 October 2004. NIAES was one of 10 co-sponsors. About 500 scientists and policymakers, including 150 foreigners (about 50 Japanese) participated. The main theme of the conference was "The impact of population



Representative members of the organizing committee of the Third International Nitrogen Conference and the Nanjing Declaration.

growth and economic development on the nitrogen cycle: consequences and mitigation at local, regional, and global scales". Continued increases in population and economic growth, particularly in developing countries, will require commensurate increases in food production and energy demand. Hence, consumption of synthetic N fertilizers and energy will further increase and thus impose even greater pressure on the environment. The main issue of the 2004 conference was whether this increased use of N and energy can be achieved while protecting environmental quality and natural resources for future generations. Because China is the world's biggest consumer of N fertilizers, many papers dealing with the N load derived from agricultural activities, and technologies for its mitigation, were presented.

On the final day, the "Nanjing Declaration on Nitrogen Management" was adopted by all participants as the conference's conclusion. The Nanjing Declaration is an action plan for facilitating environmental protection and the optimization of N management in food and energy production. It urges participants to call upon their national governments to optimize N management on local, regional, and global scales. The Declaration was signed by Zhoaliang Zhu (Co-chair of the conference, Institute of Soil Science, CAS), Katsu Minami (Co-chair of the conference, NIAES), and James Galloway (Chairperson of the International Nitrogen Initiative (INI), University of Virginia) and handed over to the United Nations Environment Program. The declaration document is available on INI's website at http://www.initrogen.org/. The Fourth International Nitrogen Conference will be held in Brazil in 2007.

The conference was followed by a Sino-Japan Workshop on "Impacts of Nutrient Cycling in Rice-based Ecosystems and Their Environmental Consequenceses" (16 and 17 October 2004, Institute of Soil Science (ISS), CAS, Nanjing). The workshop was co-organized by ISS and NIAES on the basis of a research cooperation agreement (Memorandum of Understanding) made between ISS and NIAES in July 2002. There were about 30 participants from China, 1 from Taiwan, and 18 from Japan (11 from NIAES). In the first part of the workshop, current research topics (7 from Japan and 5 from China) were presented and discussed. In the second part, to explore future research cooperation between the two institutes, group discussions were held on 3 themes: (1) Strategies for raising N utilization efficiency and thus mitigating non-point agricultural N pollution; (2) Nitrogenous gas emissions from agricultural

ecosystems; and (3) Assessment of N cycles in Asia as a result of anthropogenic influences and cooperation. Finally, a wrap-up discussion was held, and the participants concluded that they would facilitate further research cooperation. (M. Saito)

3. Word Rice Research Conference 2004

The Word Rice Research Conference 2004, "Rice is Life", was organized by NIAES in collaboration with such organizations as the Ministry of Agriculture, Forestry and Fishery (MAFF) , the Japan International Research Center for Agricultural Sciences (JIRCAS), and the International Rice Research Institute (IRRI) and was held from 5 to 7 November 2004 at the Tsukuba International Congress Center. This conference was the most important scientific event of the International Year of Rice, which had been declared by the United Nations. The objective of the conference was to provide the latest research information on a wide range of rice-related issues, such as international food security, poverty alleviation, and the environment. Forty-two countries and areas took part, and Japanese and foreign participants numbered 1235, including those from research institutions, universities, and the private sector.

Following opening addresses given by Mr. K. Nishikawa (MAFF), Dr. N.V. Nguyen (FAO), and Dr. K. Otsuka (IRRI), 3 keynote lectures were presented, by Prof. V. Smil from the University of Manitoba ("Feeding the world: How much more rice do we need?"), Prof. R. Nakamura from Nihon University ("Development of sustainable agriculture based on rice, water, and the living environment"), and Dr. R. Cantrell of IRRI ("Research strategy for rice in the 21st Century"). Two of the 20 sessions of the conference—"Conservation of soil, water, and the environment in rice culture" and "Climate change and rice production"—were organized by NIAES. M. Saito (Department of Environmental Chemistry), T. Imagawa, and Dr. T. Hasegawa (Department of Global Resources) were the chairs of these sessions.

APASD system demonstration by Dr. M. Matsui, NIAES (right).

Exhibitions were also held by 35 organizations, and the close communication between presenters and participants added a good atmosphere to the conference. NIAES showed a video program introducing NIAES activities. We also presented posters on research topics, books, and proceedings of international conferences held by NIAES, and M. Matsui (Department of Biological Safety) demonstrated the Asian-Pacific Alien Species Database (APASD) system on a personal computer. This demonstration attracted many participants. (I. Taniyama)

4. Second International Symposium on Japan–Korea Research Cooperation: Assessment of the Impact of Farm Chemical Runoff from Paddy Fields on Biodiversity Conservation

Rice farming has supplied the staple food for several thousand years to many peoples in the countries of the Asian monsoon region. We can see the great influence that rice farming has had on the culture of each country. These countries are characterized by a humid landscape in which the rural areas are composed mainly of paddy fields. Because some of the components of this landscape, such as the channels and reservoirs used for paddy irrigation, are used as habitats by various aquatic organisms, we are quite familiar with the diversity of species living there.

Most countries of the Asian monsoon region need to improve rice yield to sustain their increasing populations. Therefore, farm chemicals have been utilized continuously for rice farming in these countries, and they will continue to be used in future. The OECD has warned our governments to use farm chemicals more carefully, particularly if we are to reduce and manage their impacts on the environment and on human health. However, in our countries, the environmental safety of the chemicals used in rice farming has been judged only from the results of toxicity tests on the fish and crustaceans that make up commercial fisheries, so we have accumulated little knowledge of methods of assessing the ecological impacts of these chemicals on biodiversity, regardless of the urgent demand for effective assessment.

Therefore, an international workshop on impact assessment of farm chemicals, co-sponsored by NIAES and NIAST (National Institute of Agricultural Science and Technology, Korea), was held on 16 March 2005 in the Tsukuba International Conference Hall. The keynote

speech was given by Dr. Kevin Costello (Environmental Protection Agency, USA). He spoke on "Aquatic ecological risk assessments for pesticides: state of the science and future directions". Four speakers gave presentations in the first session, titled Biodiversity and Endangered Species in Paddy Ecosystems of East Asia. The presentations were 1) "Assessment of overall pesticide effects on river ecosystems on the basis of bioassays, biomonitorings, and/or field experiments" (S. Hatakeyama, National Institute for Environmental Studies, Japan); 2) "Biodiversity assessment of freshwater invertebrate fauna with pesticide application in paddy eco-system (M. Han, NIAST); 3) "Impact assessment of sulfonylurea herbicides on the diversity of aquatic plants in paddy farming systems of Korea" (T. Park, NIAST); and 4) "Effects of herbicides on biodiversity of rice fields in China; a rational herbicide application strategy" (J. Shen, Shanghai Jiao Tong University, China).

The second session, Methodology of Toxicity/Exposure Experiments using Aquatic Organisms, was composed of the following four presentations: 1) "Monitoring and modeling of pesticide fate and transport in paddy fields: challenges for reducing environmental risk" (H. Watanabe, Tokyo University of Agriculture and Technology, Japan); 2) "Hazard assessment of rice herbicides in freshwater algae in Japan" (S. Ishihara, NIAES)' 3) "Impact assessment of herbicide runoff from paddy fields on threatened aquatic plants in Japan" (H. Ikeda, NIAES); and 4) "Evaluation of ecological effect of farm chemicals" (F. Heimbach, Bayer Crop Science GmbH, Germany). More than 150 people participated in the seminar.

Second International Symposium on Japan–Korea Research Cooperation, held in the Tsukuba International Conference Hall.

We confirmed the impact of recent rice farming on the biodiversity in paddy ecosystems and discussed methods for assessing the ecological impacts of farm chemicals from the following standpoints: 1) deterioration of biodiversity in paddy ecosystems in Asian countries; 2) decrement of aquatic species as a result of exposure to farm chemicals in runoff from paddy fields; and 3) the use of indicator species (e.g. algae, plants, and small fish) to evaluate the ecological impacts of chemical runoff from paddy fields. We recognized the need to promote research on methodologies for assessing the risks posed by farm chemicals to biodiversity conservation. (Y. Ogawa)

International and Domestic Research Collaboration

Memorandum of Understanding between NIAES and NAFRI of Lao PDR

On 16 August 2004, NIAES and the National Agriculture and Forest Research Institute (NAFRI) of the Lao People's Democratic Republic established a Memorandum of Understanding (MOU) on Scientific Collaboration. NAFRI is the representative organization for agro-environmental research in Laos. Its headquarters are in Vientiane, and several local research centers are located around the country.

The objective of the MOU is to promote research collaboration on agro-environmental issues, mainly in Laos. The "Geo-scientific and agronomic study for enhancing CO_2 sink capacity and sustainable food production in the slash/burn ecosystems of the mountainous mainland of Southeast Asia" was begun in 2004 to investigate the long-term and wide-area carbon balance in the slash/burn ecosystem of northern Laos, and to develop alternative land-use and ecosystem management options for the region (Project Leader: Dr. Yoshio Inoue of NIAES). The MOU also covers collaborative activities by participants from the Forestry and Forest Products Research Institute and Kyoto University in Japan.

The project involves a number of on-site surveys and experiments, as well as the collection of geospatial and statistical information; these activities are supported in part by NAFRI under the MOU. The research project has been smoothly executed, and it has resulted in the development of a volume of original data sets and new scientific achievements from the agro-environmental, geo-scientific, and socioeconomic perspectives. As part of the collaboration, Dr. Linkham Douangsavanh, head of the socioeconomic research laboratory at NAFRI, was invited to NIAES for 4 months in 2005 to work with Dr. Inoue.

Entrance to the NAFRI headquarters in Vientiane.

This is the first MOU between a Japanese research institution and NAFRI. We hope that collaboration through the exchange of scientists, data, and techniques will greatly benefit both institutions in terms of domestic and international agro-environmental issues. (Y. Inoue)

Visitors

1. Science Camp 2004

Science Camp 2004, sponsored by the Japan Science Foundation, was held at various institutes to enable high school students to experience advanced science and technology. The Science Camp at NIAES took place from 18 to 20 August 2004, with 12 students. Each student participated in one of three courses: A) Examination of allelopathic interactions between plants, B) Examination of ion behaviors in soil, and C) Observation of microorganisms in plants and soils.

After the opening ceremony, the students underwent an orientation to the Camp and a tour of the Institute's facilities. On the second day, they undertook laboratory or field experiments and observations with Institute specialists in each course. On the third day, the Institute held a meeting where the students presented the results obtained in their courses. The students seemed to have developed even more interest in agro-environmental sciences or advanced science and technology through their experiences. (Photos 1, 2)

Photo 1 Students collecting experimental samples.

Photo 2 Students conducting experiments.

2. Open House Day

The Institute opened its door to the public on 14 April during Science and Technology Week 2004. The visitors included students and various professionals—more than 1300 in total, including some overseas visitors. They studied panel displays on research topics, observed specimens, attended lecture meetings, tried hands-on experiments, and participated in vegetable picking in the field, all of which events were arranged under the general theme "Let's hand down our rich land and environment to future generations." The result of a questionnaire that we collected indicated that this event was a great opportunity for the general public to learn about agro-environmental sciences. (Photos 3, 4)

Photo 3 Visitors looking at the research exhibition.

Photo 4 Visitors listening to a staff member's talk on invasive dandelions.

Advisory Council 2004

The Advisory Council 2004 met on 26 April 2004 at NIAES to provide outside opinions and recommendations on the management of NIAES. The members of the council are external experts, including a professor, a consumer representative, and the directors of other national institutions (see Appendix).

Members were informed of the general activities of NIAES in 2003 and were presented with the main research results for 2001–03.

The opinions expressed by the members were as follows:

1) NIAES is very highly motivated in its actions and is performing trials with special features. I want NIAES to continue this approach.

2) When an organization's system changes, different approaches are tried, but this attitude tends to be lost with time. Please do not forget this stance of challenging new things.

3) Please do not adhere to the principle of immediate evaluation; do work that is worthwhile and has true meaning, and don't be particular about the at-hand results.

4) The official announcement of an environmental report may be called for after 2005. Please release proactively the information that environment is considered in NIAES.

5) I am evaluating the progress of NIAES is taking various actions, such as installing a research assistant system in order to substantially accelerate the study process.

6) I understand that NIAES has established a project research committee and is making efforts to receive competitive funding. Please try hard to improve the quality of the staff and to acquire postdoctoral research fellows that will help you to reach this high level of quality.

7) NIAES has various information sources, such as the Natural Resources Inventory, which is utilized widely by many researchers. Environmental Research Organizations in Japan need to compile this kind of information into a database and update it regularly to generate a universal database that will extend research opportunities.

8) Observation is important work for NIAES. In cooperation with Environmental Research Organizations in Japan, NIAES should continue its observations of global resources.

9) In risk analysis studies, it is important to do probabilistic evaluations.

10) To establish a method of removing the cadmium accumulated in the rice, it is important to do research that can see the big picture and involve cooperation with related fields of study.

11) It is important to clarify the mechanisms by which contaminants such as cadmium accumulate. Furthermore, in parallel with such fundamental research, NIAES needs to forge ahead with developing a grasp of actual conditions and technical developments.

12) I want NIAES to establish techniques for monitoring the agricultural environment and for early environmental evaluation; by using these techniques we could take field data and use them to preserve the agricultural environment.

13) I want NIAES to offer information on research results proactively and to participate in the development of environmental standards in relation to, for example, crops, while cooperating with the administration.

14) There is need to offer important information to society quickly and to urge caution in cooperating with the administration.

15) NIAES is expected to act as a think-tank for agricultural and environmental policy. It is required to offer the results it obtains not only to the administration, but also to citizens' groups and NGOs that have an interest in the environment.

16) I think there is a high possibility that NIAES will produce valuable results and will produce researchers of high standard. The production of prominent researchers will be a strong indicator of the value of NIAES to our society.

Academic Prizes and Awards

1. Progress Award of the Japanese Association for Arid Land Studies, 2004

Studies on climate and human activity in arid areas of China and especially the Taklimakan Desert

The Japanese Association for Arid Land Studies presented its progress award to Dr. Mingyuan Du in 2004 for his outstanding research activities on climate and human activity in arid areas of China, especially in the Taklimakan Desert.

Dr. Du has been conducting research in this field for nearly 14 years. In 1991, as an STA (Science and Technology Agency of Japan) fellow at the Tropical Agriculture Research Center (TARC) of MAFF, he began cooperative research on the prevention of sand drift in arid lands. TARC introduced polyethylene windbreak nets to arid China in an effort to prevent sand drift and wind erosion. The cooperative research results suggested that the establishment of wide, multi-windbreak belts, including shrub and grass shelter belts, windbreak nets, and windbreak forest shelter belts, should be considered at the margins of oases to prevent sand drift and desertification. Windbreak nets can be used initially as front-line strategies because of their convenient setup and benefits, which include the protection of vegetation against sand blast, control of soil and wind erosion, and creation of microclimates (e.g. by reduction of evapotranspiration) conducive to vegetation growth. Polyethylene windbreak nets are now widely used in the arid areas of China.

Since 1991, Dr. Du has focused his research on the relationship between recent climate change and human activity in the arid areas of China, and especially in the Taklimakan Desert. By analyzing meteorological data, performing on-the-spot investigations, and interviewing farmers, he has found that the local climate in Xinjiang, China, and especially in the oases of the Taklimakan Desert, has become favorable for agricultural activity: the temperature has increased in winter and decreased in summer, and precipitation has increased in summer. This change in the local environment is mainly the result of climate change in recent years owing to the expansion of oases, an increase in the number of plantings and growth of windbreak forests, and increased control of (and thus a decrease in) the cutting of firewood. Thus, he points out that there are two different feedback relationships between oasis development and climate change: (1) oasis development ⇒ climate becomes favorable ⇒ more development of oases ⇒ climate becomes more favorable, and (2) oasis degradation ⇒ climate becomes worse ⇒ more degradation of oases ⇒ climate becomes even worse. This feedback effect occurs depends mainly on how people use the natural resources, and especially the water resources, in arid lands. Dr. Du suggests that it is very important to use water resources efficiently but not to expand the area of oases in future.

Over the past 14 years, Dr. Du and his colleagues have published 20 papers in the *Journal of Arid Land Studies* of The Japanese Association for Arid Land Studies, as well as more than 30 papers in other academic journals. His research achievements are proving very useful in the development of arid areas of China, especially in the Taklimakan Desert.

2. Research Award of the Japanese Society of Soil Science and Plant Nutrition, 2004

Establishment of methods for assessing allelopathy, and isolation of allelochemicals useful in agriculture

In 2004 Dr. Yoshiharu FUJII, a research leader in the Chemical Ecology Unit, was awarded the 49th Research Award of the Japanese Society of Soil Science and Plant Nutrition.

His achievements for this award are summarized as follows:

1) Exploitation of new methods of assessing allelopathy

Allelopathy, a chemical interaction between plants and other life, is a complex phenomenon that has 4 routes of action. To evaluate route 1 (root exudates), a method of mixed planting of donor and acceptor plants in agar medium in the same plant box was established and named the “Plant Box Method”. To evaluate route 2 (leaf leachates), the inhibitory effect of leaf litter was evaluated by placing leaves between 2 layers of agar, a method named the “Sandwich Method”. To investigate route 3 (emission of volatile chemicals), the “Dish Pack Method”, using packing apparatus for evaluation of atmospheric effects, was established. For route 4 (release of allelochemicals to the rhizosphere soil), the “Rhizosphere Soil Method”, using rhizosphere soil separated from the surface of the root, was exploited.

2) Screening of allelopathic plants by bioassay

By using specific methods, Dr Fujii evaluated the allelopathic activities of 1200 plant species over a 10-year period at NIAES. The most promising plants were velvet

bean (*Mucuna pruriens*), hairy vetch (*Vicia villosa*), *Lycoris radiata*, *Sphenoclea zeylanica*, and *Duranta repens*. Using the Plant Box Method, rice cultivars with strong allelopathic characteristics were also evaluated, and red rice (the old traditional shrine rice) cultivars were found to be strongly allelopathic.

3) Isolation of active constituents of allelochemicals

To isolate active allelochemicals, in addition to the specific activities of natural chemicals in plants, their concentrations were taken into consideration. By means of this strategy, L-3,4-dihydroxyphenylalanine (L-DOPA) was isolated from the velvet bean. Lycorine and related alkaloids were isolated from *Lycoris radiata*. Rutin, gallic acid, and fagomine were isolated from buckwheat. Methyl isothiocyanate was isolated from the spider lily (*Cleome spinosa*). From a newly invasive weed, *Sphenoclea zeylanica*, a series of new cyclic dithiolane compounds were isolated and named Zeylanoxides. From the steam distillation concentrate of cut-off mixtures of young tree twigs of Japanese endemic trees, 1,2-propanediol was identified as a chemical that promotes plant growth.

4) Practical application of allelopathic cover plants in the field

Hairy vetch was found to be very promising for weed suppression and vegetation control in the field. Hairy vetch is a leguminous pasture plant, and when sown in fall it covers the surface of the land almost completely by spring, and suppresses weeds almost completely. After blooming in June, it eventually dies and produces a heavy mulch-like straw. Hairy vetch could produce 200 to 400 kg of nitrogen per hectare by nitrogen fixation and could serve as a good green manure. These characteristics led Dr Fujii to conclude that hairy vetch is very suitable for weed control under fruit trees or in abandoned fields. Hairy vetch is now gradually being distributed in Japan for these purposes.

Cyanamide was identified as an allelochemical in hairy vetch. Cyanamide is a constituent of the well-known synthetic nitrogen fertilizer calcium cyanamide, but Dr Fujii's was the first finding of cyanamide as a natural chemical in a plant.

3. Award of The Society for the Study of Evolution, Japan 2004

Dr. Nobuhiro Minaka, Department of Global Resources, won the Award ("Education and Outreach of Evolutionary Biology") of The Society for the Study of Evolution, Japan, in 2004. Dr. Minaka won this award for his excellent management of the "EVOLVE" mailing list over 10 years.

The EVOLVE mailing list is an Internet community of scientists and researchers who have general or specific interests in evolutionary biology. Dr. Minaka founded this mailing list on a server of the Computer Center for Agriculture, Forestry and Fisheries Research, MAFF, in September 1994. It is at present the only academic mailing list for evolutionary biology in Japan. The cumulative number of members of EVOLVE exceeded 1800 in July 2005. Members include professors, researchers, graduate students, and high school teachers. Various themes and topics concerning the evolution of organisms have been discussed and debated on EVOLVE, and some threads of mail exchanges have resulted in collaborative projects and activities at academic meetings and congresses, as well as books and other scientific activities.

The Award Committee of The Society for the Study of Evolution, Japan, evaluated Dr. Minaka's management of this mailing list over the past 10 years as a remarkable achievement in enlightenment and outreach regarding evolutionary thought to wider and younger generations in Japan.

4. The Japanese Society of Soil Science and Plant Nutrition Award for the Encouragement of Young Scientists

Effect of interaction between ligands and ions on chemical reactions in soil

The Japanese Society of Soil Science and Plant Nutrition presented its annual award for the encouragement of young scientists to Dr. N. Yamaguchi, because her research has contributed remarkably to the advancement and development of soil chemistry pertaining to soil surface reactions.

To predict the mobility and future risks of nutrients

and pollutants in the soil environment, it is important to elucidate the mechanism of the physicochemical reactions occurring at the soil–water interface. Dr. N. Yamaguchi has addressed sorption and complexation reaction mechanisms by focusing on the interactions between the ligands and ions that play important roles in the reaction processes.

Water molecules are the most important ligands involved in the sorption reaction at the soil–water interface. Dr. Yamaguchi has applied a precise thermodynamic technique, dilatometry, to determine changes in the interaction between water and ions during the adsorption of ions on soil minerals. She has succeeded in providing the first experimental evidence that ions and soil minerals release hydrated water molecules to form inner-sphere complexes. The affinity of the oxyanions to soil minerals is related to the hydration characteristics of the oxyanions, i.e., to the interaction between water and the ions.

Dr. N. Yamaguchi also applied some molecular-scale approaches, namely X-ray absorption fine structure (XAFS), diffuse reflectance spectroscopy (DRS), and nuclear magnetic resonance (NMR) to investigate the effects of organic ligands on the kinetics and mechanism of Ni sorption onto soil minerals, and also the formation and disappearance of the phytotoxic Al tridecamer (Al_{13}). Formation of surface-induced precipitates played an important role in the immobilization of Ni and other metals in non-acidic soils. The presence of ligand complexing with Ni inhibited precipitate formation and thereby retarded the stabilization of Ni in the soil systems. In addition, the carboxylic group of low-molecular-weight organic acids and humates played a role in decreasing the concentration of Al_{13}; therefore, the phytotoxicity of Al_{13} was less important when the soil contained sufficient amounts of organic ligands.

Seasonal Events

1. Sanaburi Festival

The NIAES Sanaburi Festival 2004 took place after work on 15 June. Sanaburi is a traditional ceremony designed to send the gods, who have stayed in the paddy fields over the rice-planting period, off to Heaven. It is also the time when farmers celebrate the trouble-free end to their hard rice-planting work. At the Festival, a rice-planting ceremony was performed and then staff members served a variety of foods and drinks to each other. The 200 participants had a good time, refreshing themselves and strengthening friendships. (Photo 1)

Photo 1 The rice-planting ceremony.

2. Harvest Festival

The NIAES Harvest Festival 2004 took place after work on 7 November to thank the gods and workers for a bountiful harvest and to enhance friendships among staff members. At the opening address, the Director General expressed his appreciation for the staff's services over the year. After the rice-harvesting ceremony had been solemnly performed, the participants, who numbered about 200, had a good time, enjoying a variety of foods and drinks served by staff members. (Photo 2)

Photo 2 Staff members making rice cakes during the Harvest Festival.